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(54) SWEETENERS

(71) We, TATE & LYLE LIMITED, a British Company, of 21 Mincing Lane, London, EC3R 7QY, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to sweeteners for ingestible products, oral compositions and sweetening compositions.

By an "ingestible product" there is meant one which in the ordinary course of use is intended to be swallowed, for instance a foodstuff or beverage, or an orally administered pharmaceutical composition. By an "oral composition" there is meant one which in the ordinary course of use is not intended to be ingested as such, but is taken into the mouth for the treatment of the throat or buccal cavity, for instance a toothpaste, tooth powder, mouth wash, gargle, troche, dental lotion or chewing gum. By a "sweetening composition" there is meant a composition which is not itself taken orally, either to be ingested or held in the mouth, but instead is intended to be added to other ingestible products or oral compositions to render them sweet, or to increase their sweetness.

Although sucrose is still the most widely used sweetening agent, many efforts have been made to find substantially sweeter alternatives which could be used when it is desired to combine a high degree of sweetness with a low calorie content and/or a low risk of dental caries, for example in dietetic products and in the manufacture of soft drinks. The two most successful non-sucrose sweeteners (that is to say sweeteners comprising a compound other than sucrose itself) to date have been saccharin and cyclamate, having respectively about 200 and about 30 times the sweetening power of sucrose, but the use of these sweeteners, particularly cyclamate, has recently been restricted or banned in some countries because of doubts about their safety. Saccharin also suffers from the disadvantage of an unpleasantly bitter after-taste which can be detected by many people.

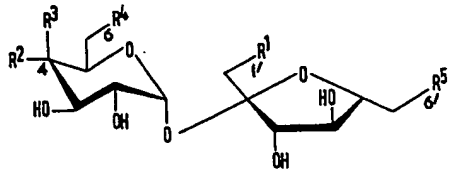
More recently, many other non-sucrose sweeteners have been investigated, some of natural origin and others synthetic, covering a wide range of chemical structures. These compounds have included proteins, such as monellin, thaumatin and miraculin, dipeptides such as aspartame, and dihydrochalcones such as neohesperidin dihydrochalcone. However, apart from the difficulties of synthesizing or extracting such sweeteners, they do not necessarily possess the same quality of sweetness as sucrose: in particular, as compared with sucrose, the sweeteners may be slow in onset and relatively lingering, and there may be a liquorice-like or other after-taste, making the sweetener unsuitable as a direct replacement for sucrose unless these differences can be masked.

Although numerous sweeteners of widely diverse chemical structures have now been investigated, it is significant to note that sweetness substantially greater than that of sucrose has not been discovered in any derivative of sucrose or in any other carbohydrates: when an intensely sweet substance has been discovered, such as saccharin, cyclamate and the other non-sucrose sweeteners already mentioned, its structure has always been radically different from that of sucrose. Indeed, it is known that the presence of some substituents on the sucrose molecule can, in fact, destroy its sweetness and even impart a bitter taste.

Most surprisingly, and in complete contrast

to previous knowledge about non-sucrose sweeteners, we have now discovered that certain derivatives of sucrose and of a sucrose isomer are very much sweeter than sucrose itself, their sweetness being comparable in intensity with that of saccharin, but having a quality similar to that of sucrose.

According to the present invention we provide as sweetening agents sucrose derivatives of the general formula



in which

R^1 represents a hydroxy group or a chlorine atom;

R^2 and R^3 respectively represent a hydroxy group and a hydrogen atom, a chlorine atom and a hydrogen atom, or a hydrogen atom and a chlorine atom, the 4-position being in the D-configuration;

R^4 represents a hydroxy group; or, if at least two of R^1, R^2, R^3 and R^5 represent chlorine atoms, R^4 represents a hydroxy group or a chlorine atom; and

R^5 represents a hydroxy group or a chlorine atom;

provided that at least one of R^1, R^2 and R^3 represents a chlorine atom.

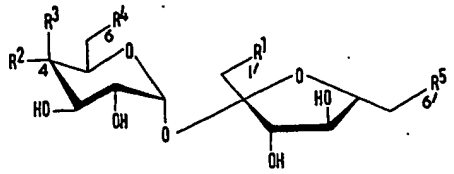
The compounds of formula (I) can be used as sweetening agents in any conventional way, including the sweetening of "ingestible products" (as previously defined), for example foodstuffs, beverages and orally administered pharmaceutical compositions, and of "oral compositions" (as previously defined), for example toothpastes, chewing gums and mouth washes. They can also be used, with conventional liquid or solid extenders and carriers, in "sweetening compositions" (as previously defined).

The extender or carrier comprises any suitable vehicle for the sucrose derivative of the general formula (I) so that it can be formulated in a composition which can conveniently be used for sweetening other products, for example granules, tablets or a solution in a dropper pack. The extender or carrier may thus include, for example, conventional water-dispersible tabletting ingredients, such as starch, lactose and sucrose itself; low-density bulking agents to provide a granular sweetening composition having a volume per unit sweetness equivalent to that of sucrose, for example, spray dried maltodextrins; and aqueous solutions containing adjuvants such as stabilizing agents, colouring agents and viscosity-adjusting agents.

Beverages, such as soft drinks, containing a sucrose derivative of the general formula (I) may be formulated either as sugar-free dietetic products, or "sugar-reduced" products containing the minimum amount of sugar required by law. In the absence of sugar it is desirable to add further agents to provide a "mouth feel" similar to that provided by sugar, for example pectin or a vegetable gum. Thus, pectin may be added at a level of from 0.1 to 0.15% in a bottling syrup.

A number of compounds of the general formula (I) which may be used according to the present invention are shown in the following Table.

TABLE.



Compound No.	R^1	R^2	R^3	R^4	R^5	Approximate sweetness (x sucrose)*
1	Cl	OH	H	OH	OH	20
2	OH	H	Cl	OH	OH	5
3	Cl	H	Cl	OH	OH	600
4	Cl	OH	H	OH	Cl	500
5	Cl	H	Cl	OH	Cl	2000
6	OH	H	Cl	Cl	Cl	4
7	Cl	OH	H	Cl	Cl	100
8	Cl	H	Cl	Cl	Cl	200
9	Cl	Cl	H	Cl	Cl	100

* *Sweetness Evaluation.*

The sweetness is evaluated in aqueous solution, by comparison with a 10% by weight aqueous solution of sucrose. The results were obtained from a small taste panel and are, therefore, not statistically accurate, but indicate the approximate order of sweetness.

The compounds in Table 1 are as follows (the systematic nomenclature is given first, followed by trivial name based on "*galacto*-sucrose" in those cases where a 4-chloro substituent is present):

1. 1′ - chloro 1′ - deoxysucrose
2. 4 - chloro - 4 - deoxy - α - D - galactopyranosyl - β - D - fructofuranoside [i.e. 4 - chloro - 4 - deoxy*galacto*sucrose]
3. 4 - chloro - 4 - deoxy - α - D - galactopyranosyl - 1 - chloro - 1 - deoxy - β D - fructofuranoside [i.e. 4,1′ - dichloro-4,1′ - dideoxy*galacto*sucrose]
4. 1′,6′ - dichloro 1′,6′ - dideoxysucrose
5. 4 - chloro - 4 - deoxy - α - D - galactopyranosyl - 1,6 - dichloro - 1,6 - dideoxy - β - D - fructofuranoside [i.e. 4,1′, 6′ - trichloro - 4,1,6′ - trideoxy*galacto*sucrose]
6. 4,6 - dichloro - 4,6 - dideoxy - α - D-galactopyranosyl - 6 - chloro - 6-deoxy - β - D - fructofuranoside [i.e. 4,6,6′ - trichloro - 4,6,6′ - trideoxy*galacto*sucrose]
7. 6,1′,6′ - trichloro - 6,1′,6′ - trideoxysucrose
8. 4,6 - dichloro - 4,6 - dideoxy - α - D-galactopyranosyl - 1,6 - dichloro - 1,6-dideoxy - β - D - fructofuranoside [i.e. 4,6,1′,6′ - tetrachloro - 4,6,1′,6′ - tetradeoxy*galacto*sucrose]
9. 4,6,1′,6′ - tetrachloro - 4,6,1′,6′ - tetradeoxysucrose.

From Table 1 it may be seen that chloro substituents at the 4-, 1′- and 6′-positions are effective in inducing sweetness. A combination of two such substituents is synergistic and in general raises sweetness by approximately one order of magnitude rather than being simply additive. Thus, for example, a 1′-chloro substituent by itself gives a sweetness of 20x and a 4β-chloro substituent by itself a sweetness of 4x. However, a 4,1′-dichloro combination gives a sweetness of 600x and a 1′,6′-dichloro combination gives a sweetness of 500x. Similarly, a combination of all three chloro substituents raises the sweetness by approximately one more order, the 4,1′,6′-trichloro derivative having a sweetness of 2000x. (All sweetnesses expressed as multiples of that of sucrose).

In contrast, a 6-chloro substituent is disadvantageous, and causes a reduction in sweetness by antagonising the action of the other substituents. For this reason, a 6-chloro substituent—R^4 in formula (I)—may only be

present when at least two other chloro substituents are present.

In general, the 6-chloro-substituted compounds are not preferred for this reason—the most sweet compounds containing 4,1'- and 6'-chloro substituents.

The remarkable sweetness of the compounds of formula (I) is combined with an LD_{50} (lethal dose 50%) which, in the case of compound 5 in Table 1, for example, is in excess of 16g/kg in mice, that being the largest dose which can be administered in practice.

Most of the compounds of the general formula (I) are known and can be prepared by the synthetic routes disclosed in the chemical literature. However, none of the known compounds has previously been recognised as possessing any useful sweetness.

Thus, Compound 5 is reported in Carbohyd. Res., *40*, (1975), 285; Compound 6 in Carbohyd. Res., *44*, (1975), 37; and Compound 7 in Carbohyd. Res., *25*, (1972), 504 and *ibid 44*, (1975), 12—13. Compound 2 is reported in Carbohyd. Res., *40*, (1975), 285—298.

Compounds 4 and 8 are claimed in copending application No. 8601/77 (Serial No. 1543168) divided from the present application.

All of the compounds of the general formula (I), both new and old, may be prepared by reaction of a sucrose ester, having free hydroxy groups in the portions required to be chlorinated, with sulphuryl chloride to obtain the corresponding chlorosulphate derivative. This, on treatment with a source of chloride ions such as lithium chloride, in an amide solvent such as hexamethyl phosphoric triamide, yields the chlorinated sucrose ester. Hydrolysis of the chloro-ester, e.g. using sodium methoxide in dry methanol, then liberates the free chlorosucrose. The reaction with sulphuryl chloride is conveniently effected at a reduced temperature in an inert solvent in the presence of a base, for example chloroform containing pyridine.

A similar method can be used for further chlorinating an already chlorinated sucrose derivative.

In general 4-chloro-sucrose derivatives can be obtained by reaction of the 4-chloro-*galacto*sucrose analogue with a source of chloride ions at an elevated temperature, e.g. 100—150°C, preferably in the presence of a catalytic amount of iodine.

The following Examples illustrate the invention further (temperatures are given in degrees centigrade).

Example 1.
1'-chloro-1'-deoxysucrose
(Compound 1).

a) 1'-chloro-1'-deoxysucrose hepta-acetate.

A solution of 2,3,4,6,3',4',6' - hepta - *O*-acetylsucrose (2g) in a mixture of pyridine (10 ml) and chloroform (30 ml) was treated with sulphuryl chloride (2 ml) at −75°C for 45 minutes. The reaction mixture was taken up in ice-cold sulphuric acid (10%, 200 ml) and dichloromethane (200 ml) and shaken vigorously. The organic layer was then successively washed with water, aqueous sodium hydrogen carbonate and water, and then dried (Na_2SO_4). The solution was concentrated and then extracted with ether. The insoluble material was filtered off and the filtrate concentrated to give the corresponding 1'-chlorosulphate derivative (2.1g).

This syrupy residue (2g) was then treated with lithium chloride (2g) in hexamethyl phosphoric triamide (HMPA) (10 ml) at 90° for 24 hours. The reaction mixture was poured into ice-water, and the precipitate formed was collected, washed with water, and taken up in ether. The organic layer was dried over sodium sulphate, concentrated and eluted from a silica gel column with ether-light petroleum (1:1) to give the 1'-chloro-hepta-acetate as an amorphous powder $[\alpha]_D$ + 55.0° (*c* 1.2, $CHCl_3$); n.m.r. data: τ 4.29 (*d*, $J_{1,2}$ 3.5Hz, H-1); 5.11 (*dd*, $J_{2,3}$ 10.0Hz, H-2); 4.56 (*t*, $J_{3,4}$ 9.5Hz, H-3); 4.94 (*t* $J_{4,5}$ 9.5 Hz, H4); 4.32 (*d*, $J_{3',4'}$ 6.5Hz, H-3'); 4.60 (*t*, $J_{4',5'}$ 6.5Hz, H-4'); 7.84—8.01 (7 Ac.). Mass spectral data: [(a) indicates ions due to hexapyranosyl cation and (b) a 3:1 doublet (1Cl) due to ketofuranosyl)]: me/ 331 a, 307 b, 187 b, 169 a, 145 b, 109 a.

Analysis calculated for $C_{26}H_{35}ClO_{17}$:
C, 47.7; H, 5.4; Cl, 5.4%
Found:
C, 47.5; H, 5.6; Cl, 5.7%.

(b) 1'-chloro-1'-deoxysucrose.

A solution of the above intermediate (1g) in dry methanol (10 ml) was treated with a catalytic amount of *M* sodium methoxide in methanol at room temperature for 5 hours. T.l.c. (dichloromethane - methanol, 3:1) showed a slow-moving product. The solution was deionized by shaking with Amberlyst—15 (a polystyrene sulphonic acid resin, Amberlyst being a Registered Trade Mark), in H^+ form, concentrated, and purified by shaking an aqueous solution of the syrup with petrol. The aqueous layer was then concentrated and dried under vacuum to give 1'-chloro-1'-deoxysucrose $[\alpha]_D$ + 57.8° (*c* 0.7, water).

Analysis calculated for $C_{12}H_{21}ClO_{10}$:
C, 39.9; H, 5.9; Cl, 9.8%
Found:
C, 39.7; H, 6.1; C, 9.7%.

Example 2.
4,1'-dichloro-4,1'-dideoxygalactosucrose
(Compound 3).

(a) 2,3,6 - Tri - O - acetyl - 4 - chloro-

4 - deoxy - α - D - galactopyranosyl-3,4 - di - O - acetyl - 6 - O - benzoyl-1 - chloro - 1 - deoxysucrose.

A solution of 2,3,6,3',4' - penta *O* - acetyl-6' - *O* - benzoylsucrose (2g) in a mixture of pyridine (10 ml) and chloroform (30 ml) was treated with sulphuryl chloride (2 ml) at −75° for 45 minutes. The reaction mixture was poured into ice-cold sulphuric acid (10%, 200 ml) with vigorous shaking and then extracted with dichloromethane. The organic layer was washed successively with water, aqueous sodium hydrogen carbonate, and water, and dried (Na_2SO_4). The solution was concentrated and extracted with ether. The insoluble material was filtered off and the filtrate concentrated to give the chlorosulphate (2.1g). This intermediate was then treated with lithium chloride as in Example 1 to give the above-named chloro intermediate.

(b) 4 - chloro - 4 - deoxy - α - D - galactopyranosyl - 1 - chloro - 1 - deoxy - β - D - fructofuranoside.

A solution of the above intermediate from (a) (1g) in dry methanol was treated with a catalytic amount of *M* sodium methoxide in methanol at room temperature for 5 hours. T.l.c. (dichloromethane - methanol, 4:1) showed one product. The reaction was worked up as described in Example 1(b) to give the title product as a syrup, $[\alpha]_D$ + 49.6° (*c* 0.7, water).

Analysis calculated for $C_{12}H_{20}Cl_2O_9$:
C, 38.0; H, 5.3; Cl, 18.7%
Found:
C, 35.7; H, 6.0; Cl, 20.4%.

By a similar method 1',6' - dichloro - 1',6' - dideoxysucrose (Compound 4) was prepared: $[\alpha]_D$ + 67° (*c* 1.0, methanol).

Analysis calculated for $C_{12}H_{20}Cl_2O_9$:
C, 38.0; H, 5.3; Cl, 18.7%
Found:
C, 37.7; H, 5.2; Cl, 17.1%.

Hexa-acetate—white solid foam, $[\alpha]_D$ + 51.7° (*c* 1.0 $CHCl_3$) Mass spectrometry m/e 331 and 283 (2 Cl). Characterized by reductive dehalogenation with Raney Nickel, H_2 and KOH to 1',6'-dideoxysucrose hexaacetate —a thick colourless syrup; $[\alpha]_D$ + 25.5° (*c* 1.0, $CHCl_3$). 100 Hz (N.M.R. (C_6D_6 τ values)—H-1, 4.36 d ($J_{1,2}$ 3.5 Hz); H-2, 4.99 q ($J_{2,3}$ 10.5 Hz); H-3, 4.17 t ($J_{3,4}$ 10.0 Hz); H-4, 4.71 (t ($J_{4,5}$ 10.0 Hz); H-1', 8.58 s; H-6', 8.60 d.

Example 3.

1,6 - dichloro - 1,6 - dideoxy - β - D-fructofuranosyl - 4,6 - dichloro - 4,6-dideoxy - α - D - galactopyranoside (Compound 8).

A solution of 6,1',6' - trichloro - 6,1',6'-trideoxysucrose (3g) in pyridine (70 ml) was treated with sulphuryl chloride (35 ml) in dry chloroform (100 ml) at −75° for 3 hours. The solution was stirred at 0 to −5° for 2 hours and then at room temperature for 24 hours. The reaction mixture was then diluted with dichloromethane (100 ml) and washed successively with ice-cold sulphuric acid (10%, 250 ml), water, aqueous sodium hydrogen carbonate, and water. The organic layer was dried over sodium sulphate and concentrated to give a syrup. The syrupy residue was dissolved in methanol (100 ml) and dechlorosulphated by means of excess barium carbonate and a catalytic amount of sodium iodide. The inorganic residue was filtered off and the filtrate concentrated to a syrup. T.l.c. (chloroform-methanol, 4:1) showed the 4,6,1',6' - tetrachloro - 4,6,1',6' - tetradeoxy*galacto*sucrose as the major product. A fast-moving minor product, probably a pentachloro derivative, was also observed. Purification on a column of silica gel, using chloroform-acetone (5:1) gave the tetrachloro derivative in 90% yield.

Precisely equivalent results were obtained by repeating the above procedure but starting from 1',6' - dichloro - 1',6' - dideoxysucrose or 1' - chloro - 1' - deoxysucrose, instead of the 6,1',6' - trichloro - 6,1',6'-trideoxysucrose.

$[\alpha]_D$ + 89° (*c* 1.0, methanol). Mass spectroscopy: m/e 199 2-Cl).

Tetra-acetate—white solid foam, $[\alpha_D]$ + 98.5° (*c* 1.0, $CHCl_3$), 100 MHz N.M.R. ($CDCl_3$, τ values)—4.28 d (H-1), 5.25 q (H-4), 4.30 d (H-3'), 4.55 t (H-4') $J_{1,2}$ 3.5 Hz; $J_{3,4}$ 3.0 Hz; $J_{4,5}$ 1.5 Hz; $J_{3',4'}$ 6.5 Hz; $J_{4',5'}$ 6.5 Hz. Mass spectrometry m/e 283 (2 Cl).

Tetra-mesylate—very pale yellow crystals from dichloromethane-ethanol; m.p. 120—121°; $[\alpha]_D$ + 65.5° (*c* 1.0, $CHCl_3$). 100 MHz N.M.R. ($CDCl_3$, τ values) H-1 4.18 d ($J_{1,2}$ 3.5 Hz); H-2 5.06 q ($J_{2,3}$ 10 Hz); H-3 4.77 q ($J_{3,4}$ 3.5 Hz); H-4 5.20 q ($J_{4,5}$ 1.5 Hz); H-3' 4.39 d ($J_{3',4'}$ 7.0 Hz); H-4' 4.65 t ($J_{4',5'}$ 7.0 Hz); Mass spectrometry m/e 355 (2 Cl).

Example 4.
4,6,1',6'-tetrachlorosucrose (Compound 9).

To a solution of 4,6,6' - trichloro - 4,6,6'-trideoxy - 2,3,3',4' - tetra - *O* - acetyl*galacto*-sucrose - 1' - *O* - monomesitylenesulphonate (1g) in D.M.F. (15 ml) was added excess of lithium chloride (2g) and a catalytic amount of iodine (50 mg) and the mixture was heated at 140—145° in an oil-bath for 18 hours. T.l.c. (benzene-ethylacetate 3:1) indicated the presence of a major product moving faster than the starting material. The reaction mixture was cooled, poured into ice-cold water and then extracted with ethyl acetate. The

organic extract was washed thoroughly, first with 5% sodium thiosulphate solution and then with water, and dried. The ethyl acetate was evaporated off and the residue was treated with methanol containing a catalytic amount of sodium methoxide.

T.l.c. (chloroform / acetone / methanol / water, 57:20:20:3) now showed the presence of a faster-moving minor product and a slower-moving major product—both having very similar mobilities and the latter corresponding to 4,6,1′,6′ - tetradeoxy - *galacto*-sucrose (Compound 8 (mixed t.l.c.). The mixture was fractionated over a column of silica gel using chloroform-methanol (10:1) as eluant. Although complete separation was not achieved because of the close mobilities of the two components, the first few fractions contained 4,6,1′,6′ - tetrachloro - 4,6,1′,6-tetradeoxy-sucrose which was obtained as a white solid $[\alpha]_D$ + 45° (*c* 1.0, MeOH). The structure was confirmed by n.m.r. and mass spectrometry of the following derivatives:—

Tetra-acetate—syrup, $[\alpha]_D$ + 30.5° (*c* 1.0 $CHCl_3$) N.M.R. (C_6D_6 τ values)—H-1, 4.39 d ($J_{1,2}$ 4.35 Hz); H-2, 5.14 q $J_{2,3}$ 10 Hz); H-3, 4.27 t ($J_{3,4}$ 10 Hz); H-4, 6.1 t ($J_{4,5}$ 10 Hz); H-3′, 4.20 d ($J_{3',4'}$ 9.6 Hz); H-4′, 4.62 t ($J_{4',5'}$ 6.0 Hz).

Tetra-mesylate—white crystalline compound m.p. 187° (dichloromethane-methanol) $[\alpha]_D$ + 29.9° (*c* 1.0, acetone).

Example 5.

Sweetening tablets for beverages.

Each tablet contains

Compound 3	8 mg
or Compound 5	2 mg

together with a dispersible tablet base (ca. 60mg) containing sucrose, gum arabic and magnesium stearate, and is equivalent in sweetness to about 4.5 g sucrose.

Example 6

Bulked sweetener.

A bulked sweetener having the same sweetness as an equivalent volume of sucrose (granulated sugar) is prepared by mixing the following ingredients and spray-drying to a bulk density of 0.2 g/cc:

maltodextrin solution containing dry weight	222.2 g
Compound 3	1.7 g
(or Compound 5	0.5 g).

The resulting composition has a sweetening power equivalent to approximately 2 kilograms of sugar.

Example 7.

Reduced calorie cola drink containing sugar.

Ingredients to prepare 100 ml bottling syrup:

Compound 3	80 mg
(or Compound 5	20 mg)
Sugar	60 g
Benzoic acid	35 mg
Phosphoric acid (con.)	1 ml
Cola flavour	1.1 ml
Colour	ad-lib.

Make up to 100 ml with mineral water.

This syrup may then be added in 25 ml doses to carbonated 225 ml aliquots of chilled mineral water.

Example 8.

Carbonated low calorie lemonade (sugar free).

Ingredients to prepare 100 ml syrup:

Compound 3	100 mg
(or Compound 5	19 mg)
Benzoic acid	35 mg
Citric acid (dry base)	1.67 g
Lemon essence	0.8 g

Make up to 100 ml in mineral water.

This syrup can be added in 25 ml doses to 225 ml aliquots of carbonated chilled mineral water.

Example 9.

Toothpaste.

	% by weight
Dibasic calcium phosphate	50%
Glycerol	20%
Sodium lauryl sulphate	2.5%
Spearmint oil	2.5%
Gum tragacanth	1.0%
Compound 3	0.03%
Water	23.97%

The ingredients are mixed to produce a spearmint flavoured toothpaste of acceptable sweetness but free from sugar or saccharin.

Example 10.

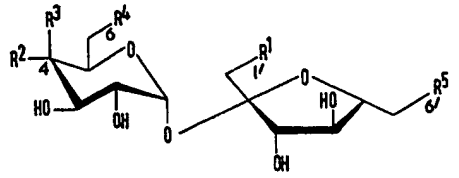
Chewing Gum.

	part by weight
Polyvinyl acetate	20
Butyl phthalylbutylglycolate	3
Polyisobutylene	3
Microcrystalline wax	2
Calcium carbonate	2
Flavouring/aroma	1
Compound 3	0.07
Glucose	10

The above chewing gum base can be cut into conventional tablets or strips.

WHAT WE CLAIM IS:—

1. A method of sweetening a substance, comprising incorporating therein a compound of the general formula (I)



in which

R^1 represents a hydroxy group or a chlorine atom;

R^2 and R^3 respectively represent a hydroxy group and a hydrogen atom, a chlorine atom, a chlorine atom and a hydrogen atom, or a hydrogen atom and a chlorine atom, the 4-position being in the D-configuration;

R^4 represents a hydroxy group; or, if at least two of R^1, R^2, R^3 and R^5 represent chlorine atoms, R^4 represents a hydroxy group or a chlorine atom; and

R^5 represents a hydroxy group or a chlorine atom;

provided that at least one of R^1, R^2 and R^3 represents a chlorine atom.

2. A method according to Claim 1, in which the compound of formula (I) has the substituent R^1 representing a chlorine atom.

3. A method according to Claim 1 or Claim 2, in which the compound of formula (I) has the substituent R^4 representing a hydroxy group.

4. A method according to Claim 1, in which the compound of formula (I) is 1',6'-dichloro - 1',6' - dideoxysucrose; 4,6-dichloro - 4,6 - dideoxy - α - D - galactopyranosyl - 6 - chloro - 6 - deoxy - β - D-fructofuranoside; 6,1',6' - trichloro - 6,1',6'-trideoxysucrose; or 4,6 - dichloro - 4,6-dideoxy - α - D - galactopyranosyl - 1,6-dichloro - 1,6 - dideoxy - β - D - fructofuranoside.

5. A method according to Claim 1, in which the compound of formula (I) is 1'-chloro - 1' - deoxysucrose; 4 - chloro - 4-deoxy - α - D - galactopyranosyl - β - D-fructofuranoside; 4 - chloro - 4 - deoxy - α-D - galactopyranosyl - 1 - chloro - 1-deoxy - β - D - fructofuranoside; 4 - chloro-4 - deoxy - α - D - galactopyranosyl - 1,6-dichloro - 1,6 - dideoxy - β - D - fructofuranoside; or 4,6,1',6' - tetrachloro - 4,6,1'6'-tetradeoxysucrose.

6. A method according to Claim 1, substantially as herein described.

7. An ingestible product or oral composition (as herein defined) containing a compound of the general formula (I) as defined in Claim 1.

8. A product or composition according to Claim 7 containing a compound of the general formula (I) in which R^1 represents a chlorine atom.

9. A product or composition according to Claim 7 or Claim 8 in the form of a beverage or other liquid also containing an additive to improve "mouthfeel".

10. A product or composition according to Claim 9, in which the additive is pectin or a vegetable gum.

11. A product or composition according to Claim 7, substantially as herein described.

12. An ingestible product or oral composition substantially as herein described in any of Examples 7 to 10.

13. A sweetening composition comprising a compound of the general formula (I) as defined in Claim 1 together with a solid extender or carrier, or a liquid extender or carrier containing an adjuvant.

14. A sweetening composition according to Claim 13 containing a compound of formula (I) in which R^1 represents a chlorine atom.

15. A composition according to Claim 13 or Claim 14 in the form of tablets, granules or a solution in a dropper pack.

16. A composition according to any of Claims 13 to 15, substantially as herein described.

17. A sweetening composition, substantially as described in Example 5 or Example 6.

18. 1'-chloro-1'-deoxysucrose.

19. 4 - chloro - 4 - deoxy - α - D-galactopyranosyl - 1 - chloro - 1 - deoxy-β - D - fructofuranoside.

20. 4,6,1',6' - tetrachloro - 4,6,1',6' - tetradeoxysucrose.

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